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16. ABSTRACT

The California Division of Highways has adopted two new test procedures aimed at detecting the amount of deleterious clay in mineral aggregates. Two separate tests are involved, one the Sand Equivalent Test, Fig. 1, (Method No. Calif. 217-B) which is applicable to the fine materials passing a No. 4 sieve, and the second, the Cleanness Test, Fig. 2, (Method No. Calif. 227-A) design for application to coarse aggregate retained on a No. 4 sieve.

The first of these methods, the Sand Equivalent Test, was originally intended for application to untreated gravel or crushed stone materials as a quick field test to detect unstable materials caused by an excess of wet clay. The test was then extended to fine aggregate for asphaltic mixtures to detect clay coatings on sand grains, and finally it was found to be significant for concrete sands as laboratory investigations showed that both strength and volume change were adversely affected when the Sand Equivalent values were low (indicating excess clay).

In order to have a companion test to assure that the coarse aggregate would be free from clay coatings, the Cleanness Test was developed. By means of an empirical formula, the numerical values derived from the Sand Equivalent Test and from the Cleanness Test have been made fairly comparable and therefore we now specify that both sand and coarse aggregate should show not less than 75 in both the San Equivalent and the Cleanness Test. Reproducibility of the tests was thoroughly investigated and it appeared that the test results were significant.

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December 1958

DEGRADATION OF AGGREGATES

By

F. N. Hveem*

The California Division of Highways has adopted two new test procedures aimed at detecting the amount of deleterious clay in mineral aggregates. Two separate tests are involved, one the Sand Equivalent Test, Fig. 1, (Method No. Calif. 217-B) which is applicable to the fine materials passing a No. 4 sieve, and the second, the Cleanness Test, Fig. 2, (Method No. Calif. 227-A) designed for application to coarse aggregate retained on a No. 4 sieve.

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Last summer, however, we were disturbed to learn that concrete aggregates between the 1 1/2" and 3/4" sieves which had passed the Cleanness Test at the original production plant would not pass the test when sampled at the weigh hopper of the batching plant. This observation led to a rather extensive investigation which is still under way. However, the initial evidence is so striking it appears worth describing to this group.

In a typical case, the aggregates are produced in a large commercial plant, at which time the material is washed thoroughly, and then as an additional precaution each truck load is flushed with a 6" stream of water during loading. Samples taken from the trucks at this point show a Cleanness value of 82. When sampled again from the same truck at the end of a 25 mile truck haul, the C.V. dropped to 78.

After unloading, going through the elevator and into the weigh hopper of the batching plant, the value dropped to 47, Fig. 3. An inspection of the aggregate at these three points indicated that this is by no means a vagary in the test method as the stone in the weigh hopper was virtually unrecognizable, being visibly coated with a heavy layer of dust and fine material, Fig. 4. This change in appearance from clean to dirty simply by the process of handling raised immediate problems as to time and place of sampling and the question of establishing the point where the materials must meet the specification.

While these questions are troublesome enough, the more serious one relates to the effect on the quality of concrete. It so happened that at the time this discovery was made the laboratory had been called upon to investigate and report on the causes for excessive cracking of a concrete building constructed about four years ago. As it is common experience to encounter delays in discharging concrete from truck mixers it was inferred that much of the concrete in the building in question may have been held in the revolving drums for substantial periods at the point of delivery, and the fact that there were such delays was confirmed by the job records. Initial trials using a small laboratory concrete mixer have shown that with prolonged mixing these aggregates grind up sufficiently to have a marked effect on the water-cement ratio.

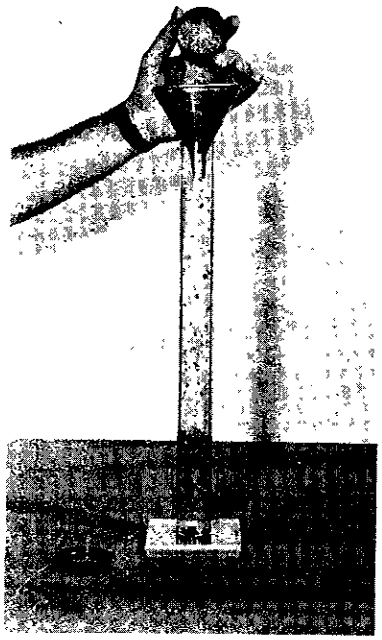
In fact, it was necessary to increase the amount of water from 5.9 gallons per sack to 11.3 gallons per sack in order to maintain a constant slump during 90 minutes of mixing.

In order to eliminate the variability of hand washing as performed by different operators, the Cleanness Value Test requires that the sample of stone be agitated and washed in a stainless steel vessel clamped to a Tyler portable sieve shaker. The standard procedure requires agitating or scrubbing the sample of 1 1/2" x 3/4" stone in water for a period of one minute. (Finer sizes are given a longer period.) In the course of the investigation, experimental runs were made in which the sample was agitated up to a period of seven minutes. Figure 5 shows that the Cleanness value is inversely proportional to the length of time the sample is agitated. Figure 6 shows a similar curve for material which has given no trouble or shown no evidence of extraordinary breakdown due to handling.

It must be emphasized that while some degradation occurs with all aggregates this extreme breakdown is by no means common. Thus far, it has been observed only with materials from one region of California. A petrographic examination discloses the fact that the degradation and development of clay may be traced to clay cemented sandstones and schists which exist in the gravel deposits. It is important to realize, however, that aggregates which meet all the conventional requirements for hardness and abrasion such as the Los Angeles Rattler Test or even the Wet Shot Test can degrade sufficiently through handling to produce an amount of clay which is detrimental and that such degradation can take place in the concrete mixer.

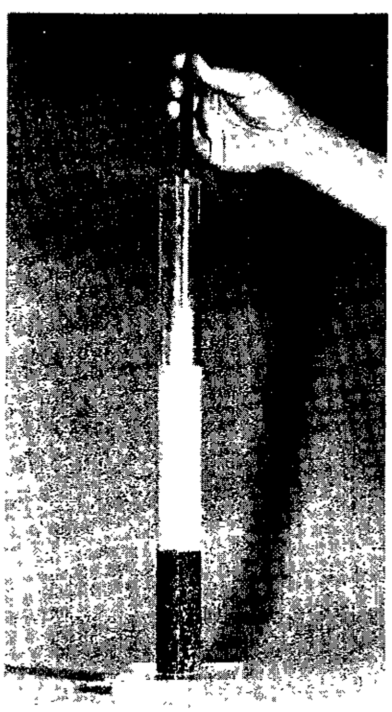
While there is ample evidence that satisfactory concrete can be manufactured from these materials, it appears obvious that it will be necessary to rigidly restrict the mixing periods when materials of this type are involved. In the light of this experience, one cannot accept without reservation the widely published conclusions that concrete may be mixed for periods ranging up to one and one half hours without adverse effects.

SAND EQUIVALENT TEST

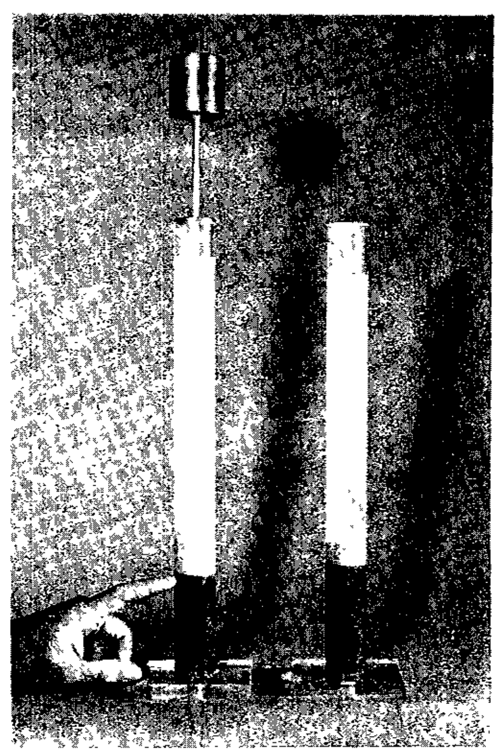


Pouring Fine Aggregate
into Calcium Chloride
Working Solution to Soak

Agitating to Remove Coatings
Break up Aggregations

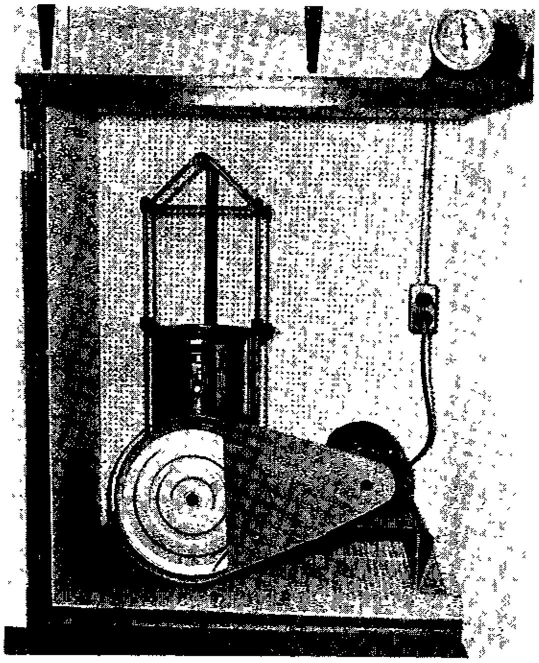


Irrigating to Elutriate
Fines from Sand



Reading the Level of the
Sand and Clay Columns

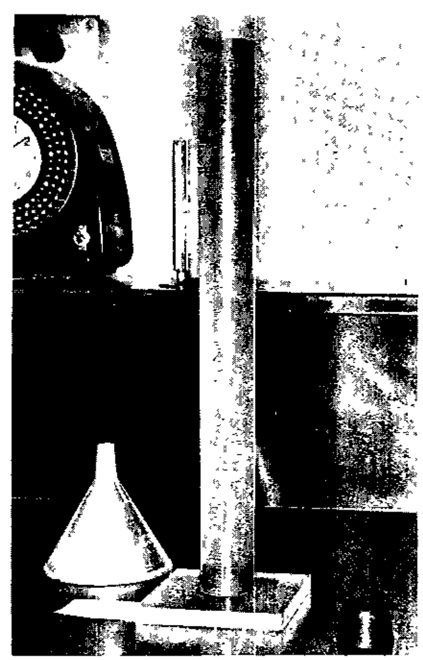
FIGURE I



Mechanical Washing of Coarse Aggregate

Separation of Aggregate and Wash Water on Nested US Nos. 8 and 200 sieves

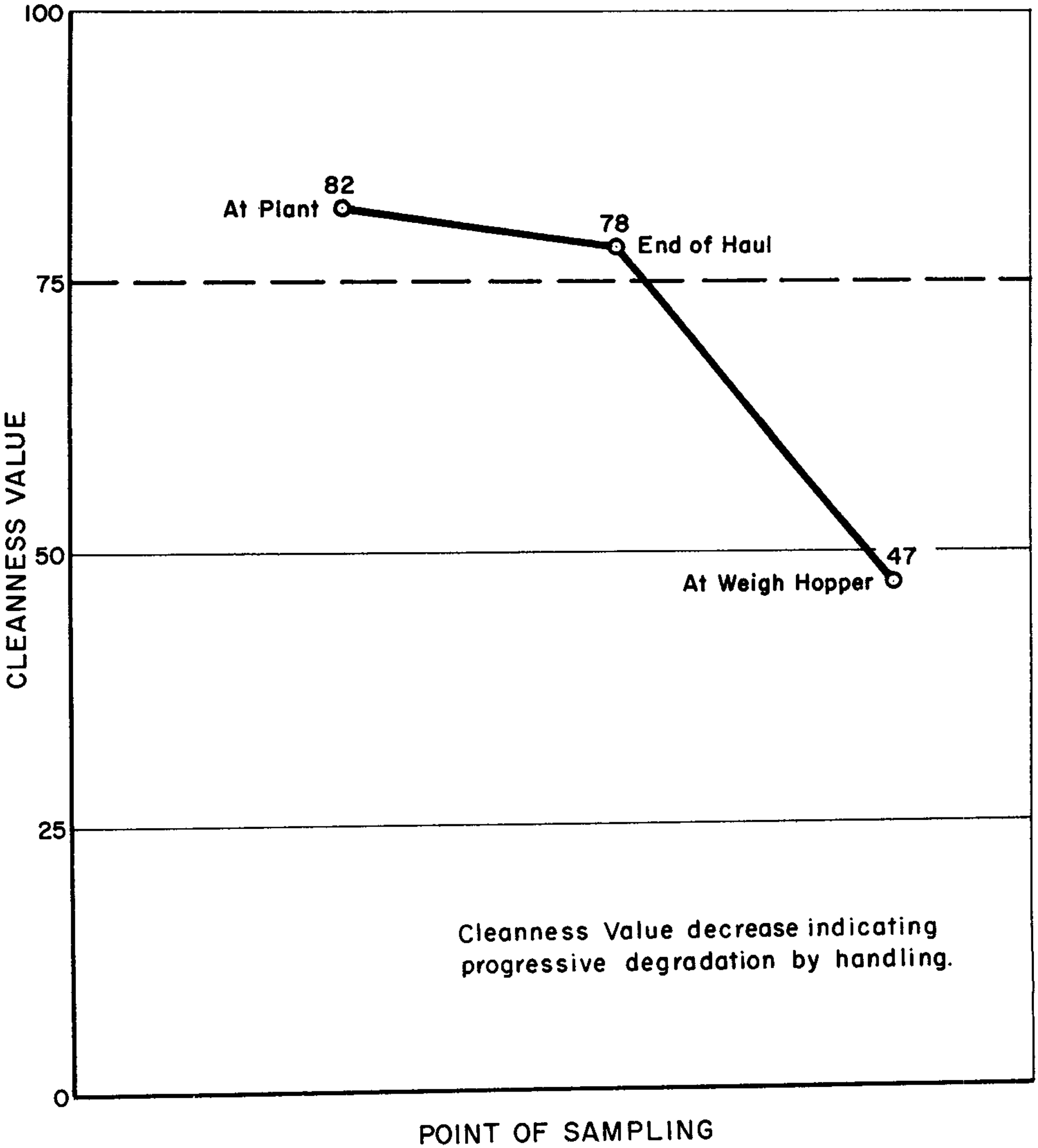
Pouring an Aliquot Portion of the Wash Water into Cylinder with 7 mls. of Calcium Chloride Solution.



Reading the Level of Sediment

FIGURE 2

Figure No. 3



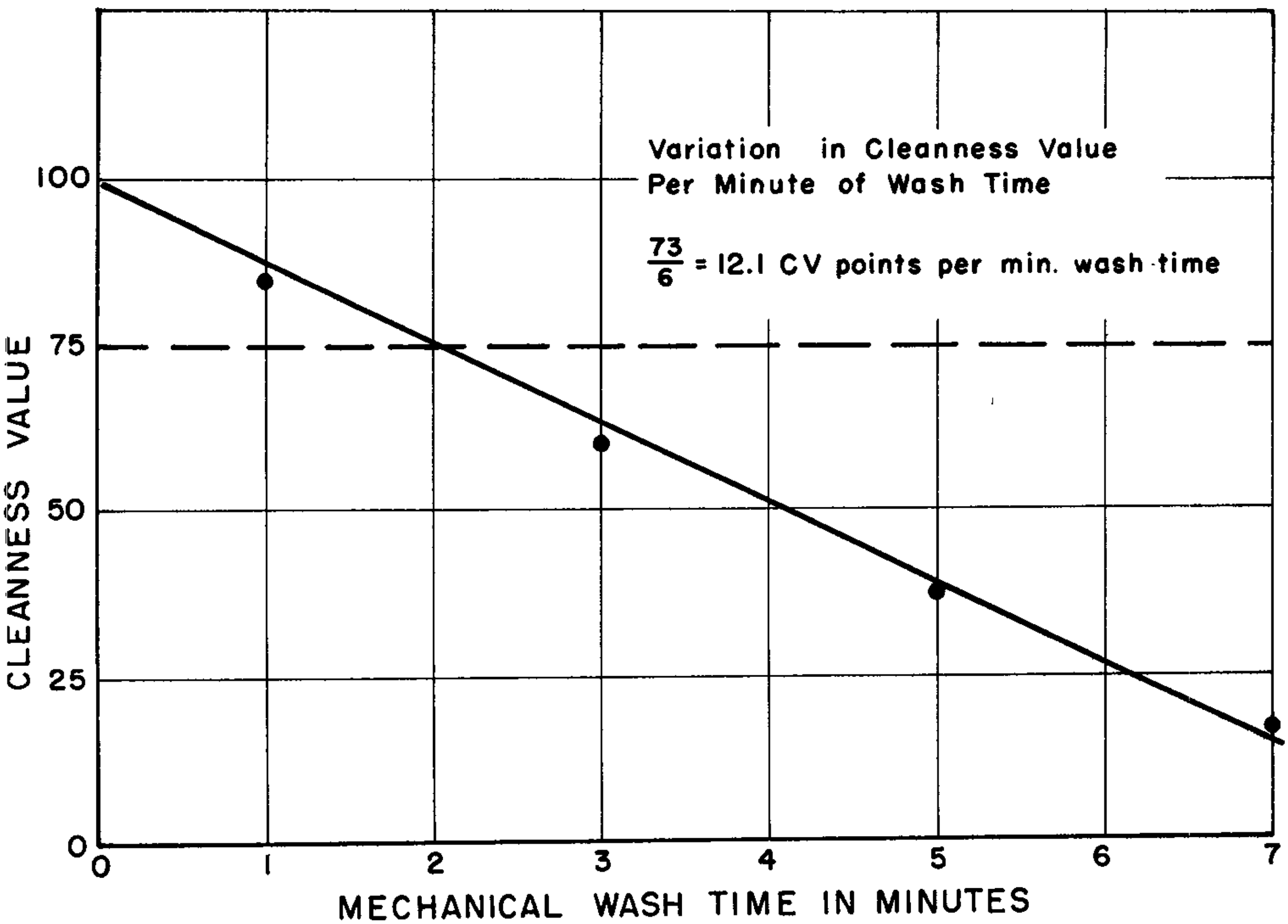
100
75
50
25
0
CLEANNESS VALUE
82
At Plant
78
End of Haul
47
At Weigh Hopper
Cleanness Value decrease indicating
progressive degradation by handling.
POINT OF SAMPLING


58-1120 6-27-58
Sampled From
Truck at Plant

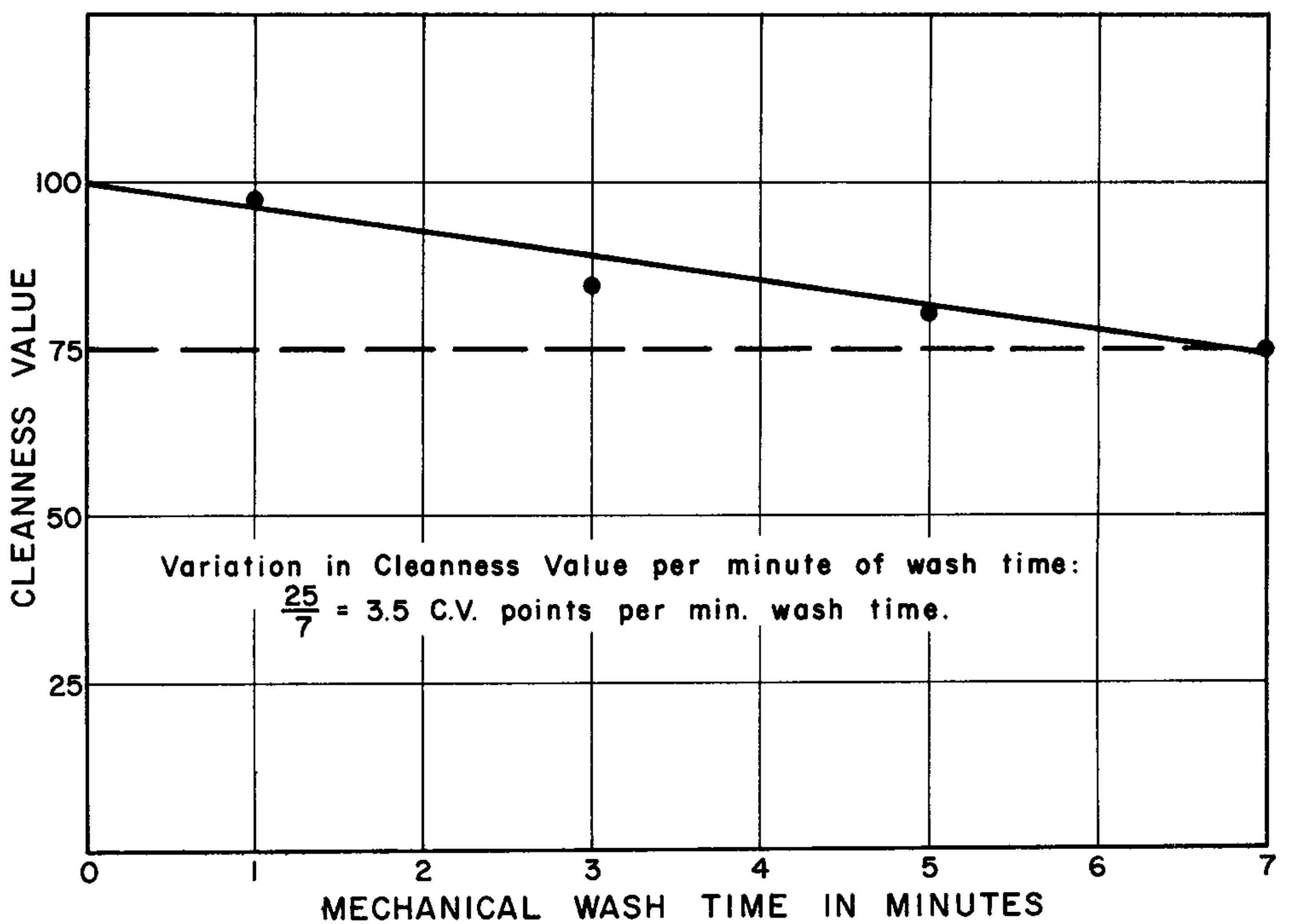

58-1124 6-27-58
Batch Plant
Weigh Hopper

FIGURE 4

Figure No. 5



TESTS ON 1 1/2" X 3/4" PCC
AGGREGATES FROM PLANT A



TESTS ON 1 1/2" X 3/4" PCC AGGREGATES

FROM PLANT B